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The Conformal Forging Technology of Major Steam Inlet Tube Special-shaped Part

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Abstract

This paper discusses a thermal processing technology that about nuclear power equipment manufacturing Moisture Separator Reheated (MSR) main steam inlet tube, it replaces the previous way of manufacturing such products with a cold process technology. This product is forged through the mould with the shape, greatly reducing the product manufacturing cycle, reducing manufacturing costs, greatly improving the product's mechanical properties. The technology has reached world leading level, replaced foreign imports successfully and realized the key components to the nuclear power equipment manufacturing domestically.

*Keywords:*Nuclear power equipment，conformal forging，special-shaped part, localization;

1. Introduction

With the gradual adjustment of Chinese energy strategy, nuclear power is undoubtedly the best clean energy, as soon as possible to achieve nuclear power equipment manufacturing domestically, to conquer the large size, difficult forgings difficulties, we should continue to increase investment, to encourage a combination of research R&D roads, placing emphasis on research on the production of guidance, in order to obtain forming manufacturers core technology of the nuclear power of the main equipment with proprietary intellectual property rights. According to information released by the IAEA, by the end of

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2004, there have been 440 nuclear power plants in operation, another 26 under construction and more than 100 are being designed. The installed capacity of power generation equipment in 2003 in china was 390 million kilowatts, and it will reach 650million kilowatts in 2010. However, as a populous nation, per capita household electricity consumption is only the world average of 1/3, power shortages in some areas can only be used as industrial and commercial power-sharing policy. In order to break the power of this serious bottleneck restricting Chinese economic development, the development of nuclear powers imperative. At present, China is studying the introduction of advanced nuclear power technology, and relying on importing to achieve the nuclear power equipment manufacturing domestically. Among them the forging of large size is the key to restrict the nuclear power equipment manufacturing domestically.

The major steam inlet tissue are the key parts to the MSR (Moisture Separator and Reheated), in the MSR for separation and re-heat and to make the steam to the low pressure cylinder superheated and to reduce the blade erosion of low pressure cylinder. Meanwhile, the MSR system played a function that it can distribute the low-pressure cylinder load reasonably and reduce the load of high-pressure cylinder. MSR has two functions: one is that it can remove about 98% of the water from the exhaust steam that it from high-pressure cylinder, the other is that it can increase the steam temperature before it entering the low-pressure cylinder.

2. The development of the major steam inlet tissue forming technique

The major steam inlet tissue are the connection parts of the MSR tube and pipe equipment, and belong to pressure boundary components working in high temperature and high pressure work environment. The major steam inlet tissue encircle size 2100mm, thickness 55mm, height 355mm, saddle-shaped as shown in Figure1. The technical standard values of Parts in Table 1, Table 2 shows, for the part, usually there are two manufacturing processes.

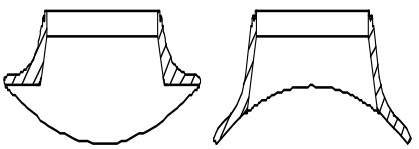

Fig.1. Main steam inlet tube shape

Table 1. Chemical composition

Element	Smelting（%）	Finished product（%）
C	≤0.25	≤0.25
Si	0.15～0.30	0.15～0.30
Mn	0.60～1.35	0.60～1.35
P	≤0.030	≤0.030
S	≤0.020	≤0.020
Cr	≤0.30	≤0.30
Ni	≤0.30	≤0.30
Mo	≤0.12	≤0.12

V	≤0.03	≤0.03
Cu	≤0.25	≤0.25
Cr+Mo	≤0.32	≤0.32

Table 2. Mechanical properties

Test item	Test temperature(℃)	Mechanical properties	Required value（MPa）
Tensile test	Room temperature	Rp0.2(MPa)	≥250
		Rm(MPa)	485～655
		4d(%)	≥22
		Z(%)	≥30
High tensile	325	Rp0.2(MPa)	≥188
		Rm(MPa)	Provide data
KV impact	-20	Single（J）	≥20
		Mean（J）	≥27
	0	Single（J）	≥22
		Mean（J）	≥31
Hardness test	Room temperature	HB	≤197

2.1. Large allowance machining process

It was forged into a flange as shown in Figure 2 first, and then processed into the shape shown in Figure 1 by mechanical processing methods. The manufacturing techniques rely mainly on mechanical processing to meet the product requirements, in regard of forging, the metal streamline distribution is unreasonable, during the subsequent machining process the metal streamlines are damaged, the corrosion will happen during the product of long-term using, thus resulting in shortened product life; Large allowance of the mechanical processing time is relatively long, his is difficult to meet the delivery requirements of industrial production; while a lot of material to be removed, this is wasteful, due to rough forging heavier, thicker wall thickness, it requires large tonnage of forging equipment , while there are still difficult to meet the requirements of ultrasonic flaw detection problem, it is difficult to succeed.

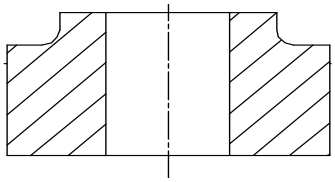

Fig.2 Flange

2.2. Solid forging processes

It was forged into forging assisted by moulding, shown in Figure 3. The inner row of holes was removed by playing multi-drill, and then machining parts to be shown in Figure 1.

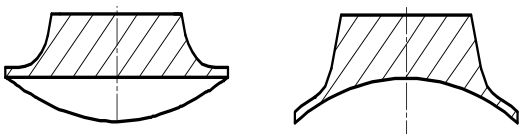

Fig.3 Forgings external shape

It was forged part of shape by molding, the metal streamlined micro-distribution have made great progress than the first manufacturing processes, but the metal streamlines direction of the inner hole were destroyed in the subsequent processing operations. There are still long processing cycle, low utilization of material, high manufacturing costs, poor mechanical properties, failed ultrasound and other issues.

3. The conformal forging process

By analyzing the shortcomings of existing production processes, this paper describes a new process technology. Through deform software simulation analysis, we have a more accurate understanding of the deformation of the forging process in the case of stress and strain, according to the simulation data, we develop a flange blank and mold structure. First, create a flange shown in Figure 4, by the stampings stretching principle, through the mold deformation shown in Figure 5, to achieve a small allowance with precision molding shape shown in Figure6. From the metal deformation process and the distribution of metal streamlines point of view, the metal streamlines along the shape of the product distribution, comprehensive mechanical performance increase, extend product life, a small tonnage of forging equipment required, reducing energy consumption; machining allowance smaller, reducing the mechanical processing time, production efficiency, high raw material utilization, lower manufacturing costs.

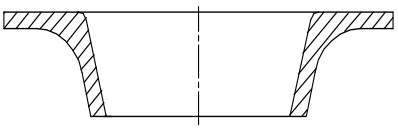

Fig.4 Blank flange

Specific implementation process as follows: first forged into a flange as shown in Figure4, Figure 4 blank flange will be heated to 1150~1220℃, while the upper and lower mould preheated to 300~400 ℃, and then smear mould release agent on upper and lower mould, and then place the die assembly on hydraulic platform, and then place the heated blank flange under the die along the mould cavity, joint the upper and lower die through guide post, hydraulic holds pressure completely after 5 minutes the remove the forgings, placed in air.

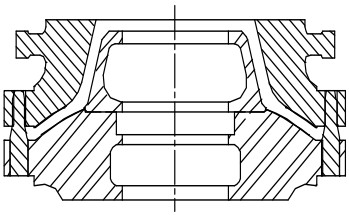

Fig.5 Mould figure

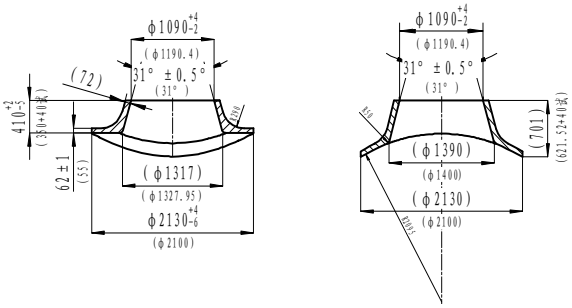

Fig.6 Main steam inlet tube forging figure

4. The test results

After testing, each index of the conformal forging technology of major steam inlet tube special-shaped part (Table 3, Table 4) are superior to standard values (Table 1, Table 2). The process technology of forging metal streamlines distribute along the shape of the products, extend product life, reducing the risk of pitting corrosion occurs that because product lines of metal streamlines is cut off , reduce the mechanical processing time, improve production efficiency, suitable for mass production, realize the key components to the nuclear power equipment manufacturing domestically.

Table 3. Chemical composition

Element	Smelting（%）	Finished product（%）
C	0.18	0.19
Si	0.28	0.26
Mn	1.08	1.06
P	0.013	0.011
S	0.003	0.006
Cr	0.07	0.07
Ni	0.09	0.07
Mo	0.03	0.04
V	0.01	0.004

Cu	0.08	0.09
Cr+Mo	0.10	0.11

Table 4. Mechanical properties

Test item	Test temperature(℃)	Mechanical properties	Required value（MPa）
Tensile test	Room temperature	Rp0.2(MPa)	370
		Rm(MPa)	540
		4d(%)	36.0
		Z(%)	74.0
High tensile	325	Rp0.2(MPa)	275
		Rm(MPa)	524
KV impact	-20	Single（J）	155, 153/160
		Mean（J）	156
	0	Single（J）	269/258/187
		Mean（J）	238
Hardness test	Room temperature	HB	161

5. Conclusions

In this paper, the conformal forging technology of major steam inlet tube special-shaped part，The technology of production of high efficiency, stable and reliable product quality, forged through the mould with the shape, greatly reducing product manufacturing cycle, reduce production manufacturing costs, greatly improve the product′s mechanical properties.

References

[1] Li-Huang. Large castings and forgings and heavy containers domestic market demand and capacity analysis[J]. China Electrical Industry; 2004, (5) : p. 13-15

[2] HUA Chun-jian,ZHAO Sheng-dun,SHEN Guang-xian. Parallel computation in numerical simulation of metal forming[J]. Forging Technology; 2005,30 (1) : p. 1-6